CLAIMS

What is claimed is:

1. A method for use with a three phase AC motor controller linked to a three phase motor, the controller receiving a torque command signal and generating a voltage phase angle as a function of the torque command signal, the voltage phase angle in turn used to generate modulating waveforms to drive a PWM inverter that provides voltages on three motor supply lines, the method comprising the steps of:

during a commissioning procedure, identifying at least one compensation angle that, when mathematically combined with the voltage phase angle, drives the motor to zero operating frequency when a zero torque command is received; and

during normal operation and when a zero torque command is received, mathematically combining the compensation angle and the voltage phase angle to generate a compensated phase angle and using the compensated phase angle to generate the modulating waveforms.

2. The method of claim 1 wherein the step of identifying a compensation angle includes driving the motor at a normal operating frequency, setting the torque command signal to zero, monitoring the motor frequency, when the motor stops decelerating, modifying the voltage phase angle until the motor frequency reaches zero and identifying the value by which the motor angle was modified to achieve the zero speed as the compensation angle.

3. The method of claim 2 further including the step of storing the compensation angle.

4. The method of claim 2 wherein the step of modifying the voltage phase angle includes, when deceleration stops:

a) determining the operating frequency;

b) negating the operating frequency to generate a frequency error value;

c) integrating the frequency error value to generate an instantaneous compensation angle;

d) mathematically combining the instantaneous compensation angle and the voltage phase angle to generate a compensated phase angle;

e) using the compensated phase angle to drive the motor; and

f) repeating steps (a) through (e) until the operating frequency is zero.

5. The method of claim 4 wherein the step of mathematically combining the instantaneous compensation angle and the voltage phase angle includes adding the instantaneous compensation angle and the voltage phase angle.

6. The method of claim 1 wherein the step of modifying the phase angle includes modifying the phase angle whenever any torque command is received.

7. The method of claim 6 wherein the step of modifying includes adding the compensation angle to the voltage phase angle.

8. The method of claim 1 wherein, when the voltage phase angle is used to drive the motor and a zero torque command is received, motor deceleration stops at a first operating frequency, the method further including the step of identifying several intermediate compensation angles during the commissioning procedure, each intermediate compensation angle, when added to the voltage phase angle, causing the operating frequency deceleration to stop at a different operating frequency between a zero frequency and the first operating frequency and, wherein, the step of using the compensation angle includes using the several intermediate compensation angles to alter the voltage phase angle during normal operation when a zero torque command is received.

9. The method of claim 8 wherein the step of identifying the intermediate compensation angles includes, when deceleration stops:

a) determining when deceleration stops;

b) determining the operating frequency;

c) storing the operating frequency and the instantaneous compensation angle;

d) negating the operating frequency to generate a frequency error value;

e) increasing or decreasing the compensation angle;

f) adding the compensation angle and the voltage phase angle to generate a compensated phase angle;

g) driving the motor with the compensated phase angle; and

h) repeating steps (a) through (g) until the operating frequency is zero.

10. The method of claim 9 wherein the step of mathematically combining the compensation angle and the voltage phase angle to generate a compensated phase angle during normal operation further includes the steps of, after a zero torque command is received during normal operation, monitoring the operating frequency and, when the operating frequency reaches a frequency associated with one of the intermediate compensation angles, mathematically combining the associated intermediate compensation angle with the voltage phase angle to generate a compensated phase angle and using the compensated phase angle to drive the motor.

11. The method of claim 10 wherein the step of mathematically combining the associated intermediate compensation angle with the voltage phase angle includes adding the angles.

12. The method of claim 1 wherein the controller also generates d and q-axis voltage values as a function of the torque command signal and uses the d and q-axis voltage values to generate the voltage phase angle, the method also for altering the d-axis voltage value to compensate for the effects of supply line capacitive charge on the d-axis voltage, the method further including the steps of mathematically combining the d-axis voltage value with a compensation factor to

generate a compensated d-axis voltage value and using the compensated d-axis voltage value along with the q-axis voltage value to generate the voltage phase angle.

13. The method of claim 12 further including the step of, prior to normal operation and during a commissioning procedure, identifying the compensation factor and storing the compensation factor for use during normal operation.

14. The method of claim 13 wherein the step of identifying the compensation factor includes driving the controller with a name plate current and measuring a first d-axis auto-tune voltage, identifying a no load d-axis current, driving the controller with the no load d-axis current and measuring a second d-axis auto-tune voltage and mathematically combining the first and second auto-tune voltages to generate the compensation factor.

15. The method of claim 14 wherein the step of mathematically combining the first and second auto-tune voltages includes the step of dividing the second d-axis auto-tune voltage by the first d-axis auto-tune voltage.

16. The method of claim 12 wherein the step of mathematically combining the d-axis voltage value with a compensation factor to generate a compensated d-axis voltage value includes multiplying the compensation factor and the d-axis voltage value to generate the compensated d-axis voltage value.

17. The method of claim 13 wherein, during the commissioning procedure, the step of identifying the compensation factor is performed prior to identifying the compensation angle and, wherein, the compensation factor is used to alter the d-axis voltage value during the procedure to identify the compensation angle.

18. The method of claim 1 wherein, when the voltage phase angle is used to drive the motor and a zero torque command is received, motor deceleration stops at a first operating frequency, the method further including the step of identifying several intermediate compensation angles during the commissioning procedure, each intermediate compensation angle, when added to the voltage phase angle,

causing the operating frequency deceleration to stop at a different operating frequency between a zero frequency and the first operating frequency and, wherein, the step of using the compensation angle includes using the several intermediate compensation angles to develop a polynomial function indicating the relationship between the intermediate angles and the operating frequencies and using the polynomial function to determine compensation angles to alter the voltage phase angle during normal operation when a zero torque command is received.

19. An apparatus for use with a three phase AC motor controller linked to a three phase motor, the controller receiving a torque command signal and generating a voltage phase angle as a function of the torque command signal, the voltage phase angle in turn used to generate modulating waveforms to drive a PWM inverter that provides voltages on three motor supply lines, the apparatus comprising:

a processor running a program to perform the steps of:

during a commissioning procedure, identifying at least one compensation angle that, when mathematically combined with the voltage phase angle, drives the motor to zero operating frequency when a zero torque command is received; and

during normal operation and when a zero torque command is received, mathematically combining the compensation angle and the voltage phase angle to generate a compensated phase angle and using the compensated phase angle to generate the modulating waveforms.

20. The apparatus of claim 19 wherein the processor performs the step of identifying a compensation angle by driving the motor at a normal operating frequency, setting the torque command signal to zero, monitoring the motor frequency, when the motor stops decelerating, modifying the voltage phase angle until the motor frequency reaches zero and identifying the value by which the motor angle was modified to achieve the zero speed as the compensation angle.

21. The apparatus of claim 20 wherein the processor performs the step of modifying the voltage phase angle by, when deceleration stops:

a) determining the operating frequency;

b) negating the operating frequency to generate a frequency error value;

c) integrating the frequency error value to generate an instantaneous compensation angle;

d) mathematically combining the instantaneous compensation angle and the voltage phase angle to generate a compensated phase angle;

e) using the compensated phase angle to drive the motor; and

f) repeating steps (a) through (e) until the operating frequency is zero.

22. The apparatus of claim 19 wherein the processor performs the step of modifying the phase angle by modifying the phase angle whenever any torque command is received.

23. The apparatus of claim 19 wherein the controller also generates d and q-axis voltage values as a function of the torque command signal and uses the d and q-axis voltage values to generate the voltage phase angle, the apparatus also for altering the d-axis voltage value to compensate for the effects of supply line capacitive charge on the d-axis voltage, the processor further performing the steps of mathematically combining the d-axis voltage value with a compensation factor to generate a compensated d-axis voltage value and using the compensated d-axis voltage value along with the q-axis voltage value to generate the voltage phase angle.

24. The apparatus of claim 23 wherein the processor further performs the steps of, prior to normal operation and during the commissioning procedure, identifying the compensation factor and storing the compensation factor for use during normal operation.

25. The apparatus of claim 24 wherein the processor performs the step of identifying the compensation factor by driving the controller with a name plate current and measuring a first d-axis auto-tune voltage, identifying a no load d-axis current, driving the controller with the no load d-axis current and measuring a second d-axis auto-tune voltage and mathematically combining the first and second auto-tune voltages to generate the compensation factor.

26. The apparatus of claim 25 wherein the processor performs the step of mathematically combining the first and second auto-tune voltages by dividing the second d-axis auto-tune voltage by the first d-axis auto-tune voltage.

27. The apparatus of claim 26 wherein the processor performs the step of mathematically combining the d-axis voltage value with a compensation factor to generate a compensated d-axis voltage value by multiplying the compensation factor and the d-axis voltage value to generate the compensated d-axis voltage value.

28. A method for use with a three phase AC motor controller linked to a three phase motor, the controller receiving a torque command signal and generating a voltage phase angle as a function of the torque command signal, the voltage phase angle in turn used to generate modulating waveforms to drive a PWM inverter that provides voltages on three motor supply lines, the method comprising the steps of:

during a commissioning procedure:

a) driving the motor at a normal operating frequency;

b) setting the torque command signal to zero;

c) monitoring the motor frequency and, when the motor stops decelerating:

i) determining the operating frequency;

ii) negating the operating frequency to generate a frequency error value;

iii) integrating the frequency error value to generate an instantaneous compensation angle;

iv) mathematically combining the instantaneous compensation angle and the voltage phase angle to generate a compensated phase angle;

v) using the compensated phase angle to drive the motor; and

vi) repeating steps (i) through (v) until the operating frequency is zero;

d) identifying the value by which the motor angle was modified to achieve the zero speed as a compensation angle; and

during normal operation and when a zero torque command is received: e) mathematically combining the compensation angle and the voltage phase angle to generate a compensated phase angle; and

f) using the compensated phase angle to generate the modulating waveforms.

29. The method of claim 28 wherein the step of modifying the phase angle includes modifying the phase angle whenever any torque command is received.

30. The method of claim 28 wherein the controller also generates d and q-axis voltage values as a function of the torque command signal and uses the d and q-axis voltage values to generate the voltage phase angle, the method also for altering the d-axis voltage value to compensate for the effects of supply line capacitive charge on the d-axis voltage, the method further including the steps of multiplying the d-axis voltage value by a compensation factor to generate a compensated d-axis voltage value and using the compensated d-axis voltage value along with the q-axis voltage value to generate the voltage phase angle.

31. The method of claim 30 further including the step of, prior to normal operation and during a commissioning procedure, identifying the compensation factor and storing the compensation factor for use during normal operation.

32. The method of claim 31 wherein the step of identifying the compensation factor includes driving the controller with a name plate current and measuring a first d-axis auto-tune voltage, identifying a no load d-axis current, driving the controller with the no load d-axis current and measuring a second d-axis auto-tune voltage and dividing the second d-axis auto-tune voltage by the first d-axis auto-tune voltage.